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Full Length Research Paper

Cattle artificial insemination cost determination by heat induction with the import of dairy breeds semen in Togo

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Nowadays, the artificial insemination remains an excellent breeding tool in dairy production. The study was carried out to determine the success rate and the unit cost of artificial insemination by heat induction using the PRID® Delta protocol. 150 doses of frozen semen of Holstein and Montbéliarde dairy breeds as well as the heat induction kit from Dakar (Senegal) were used. This study reveals the estrus rate of 92.81%, actual fertility (calving) of 47.1% and a unit cost of the artificial insemination operation of CFA F (Franc of the African Financial Community) to be 47 579.37. The parity and herd management were proven to be very significant (p ≤ 0.05) to this fertility. This relatively high unit cost of artificial insemination operation requires government subsidies for its rapid adoption by the breeders.

Keywords: Heat Induction, Artificial Insemination, Fertility, Unit Cost, Togo.

INTRODUCTION

Milk is a full product of the milking of a dairy cow, which plays a major role in the animal husbandry systems (growth and survival of calves, human nutrition, social and cultural relations, sales, etc.) (Kulo and Abalo, 2012). Therefore, the improvement in the dairy production is one of the priorities of most of the livestock development projects in Africa (Yahaman 1998; Ayele and Peacock, 2003; Dieye et *al.,* 2003; ITRA 2005; Pitala et *al.,* 2012). The dairy production of local cow breeds in Africa, which hardly exceeds 400 to 500 liters per lactation is 10 times lower than that of the European selected breeds (Boly et *al.,* 2000).

In Togo, the local dairy production covers only 28% of the estimated needs in 2010 for about 9 600 tonnes with 28% of the needs coverage (DGSCN, 2010). This production shortfall is explained by the low dairy production and productivity (1 to 4 liters per day) of local cows' breeds and poorly performing fertility parameters (Kulo and Abalo, 2012). Faced with this shortfall, the Togolese Government imported milk powder valued at nearly 3 000 tonnes in 2011 (Dao, 2013) resulting in funds shortage from 3 to 9 million dollars between 2000 and 2011 (FAO, 2012).

In order to reduce this financial drain, the Togolese Government initiated several projects in the 1980s to promote the dairy sector. But it appears clearly that all these efforts have not allowed the emergence of a dairy production capable of supply to the urban centers (Dao, 2013). In addition, some artificial insemination tests by heat induction in Togo have been experimented at the station of Avétonou using the N'Dama and local breeds semen collected on site (ITRA, 2005). From these tests, no studies on the cost of the artificial insemination

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operation have been carried out so far.

In view of this biotechnology-farm extension, this study aims at determining the unit cost of the artificial insemination operation.

MATERIAL AND METHODS

Study Area

This study was carried out in the private dairy farming centers and farms in Southern Togo. The data were collected in 16 locations within 5 districts namely Agou (03), Kloto (01) in the Plateau region; Avé (08), Zio (03) and Golfe (01) in the Maritime region. These dairy farming is located in 13 farms and 3 stations namely: the Centre de Recherche Agronomique zone Forestière (CRA-F) of Avétonou, Institut National de Formation Agricole (INFA) of Tové and the Station Expérimentale Agronomique of Lomé (SEAL) of Université de Lomé. These study farms are those established for at least five years, periodically using food creep feeding and regularly treating their animals against the trypanosomiasis and gastrointestinal parasites.

This experimental area takes advantage of a sub-equatorial climate consisting of two rainy seasons, the duration of which varies from March to mid-July for the main rainy season and from mid-September to November for the short rainy season. The rainfall varies from 800 mm on the coasts to 1 600 mm on the mountain with an average temperature ranging from 20° to 35° C (FAO, 2013).

Artificial Insemination (AI)

Import of synchronization and artificial insemination (AI) inputs

150 doses of heat synchronization hormones (PRID® Delta, PGF2a, PMSG) of frozen semen of Montbéliarde (70 doses) and Holstein (80 doses) breeds, consumables (PRID gel, search gloves, ear loops, ducts, sanitary shirts) and non-consumable material (clamp loops, PRID applicators, AI guns, tweezers, 14CM scissors, AI box and flakes defroster) were imported from the SOPRODEL company of Dakar (Senegal).

In addition to this material, consumables inputs (Oxytetracycline 20% Betadine 10%, alcohol 90%, cotton, 10cc and 2cc syringes 18G needles, soap, etc.) were bought in Lomé (Togo).

Conservation of imported inputs

Upon receipt, the material was stored in a cool place at the premises of Ecole Supérieure d'Agronomie of Université de Lomé (ESA-UL) and the PMSG hormones in a refrigerator at 5 °C. Throughout the duration of the operation from September 2015 to January 2016, the level of liquid nitrogen in a canister of nitrogen of 10 liters was regularly monitored and loadings were carried out in the « Air liquide » company when the level was reaching 5 liters.

Selection of farms and animals

The farms covered by this study are farms that have been established for at least five years, including the sale of milk, which is one of the main sources of income of the Fulani women. The animals are mostly fed on pasture with cooking salts creep feeding, salt blocks and beer gluten feed per moment. They regularly are vaccinated against trypanosomiasis and gastrointestinal parasites. The heifers were selected mainly based on the body condition score (BCS/NEC ≥ 2.5) on a scale of 0 to 5; the number of postpartum days (PPD/JPP ≥ 60) and the age of the heifers at reproduction and cycled cows. They belong to 3 breeds: N'Dama, zebu Goudali and other zebu Fulani. No genome analysis was conducted to confirm the breed of these animals.

Estrus Induction and artificial insemination

The PRID® (progesterone releasing intravaginal device with oestradiol) is consisted of a silicone inert elastomeric containing 1.55g of progesterone and a gelatin capsule containing 10 mg of oestradiol benzoate (Bouyer, 2006).

All the heifers have been diagnosed for non-pregnancy through trans-rectal palpation before being subject on the same day, to the protocol of estrus induction and synchronization through the following PRID Delta® Protocol:

- Day 0: introduction of the PRID® Delta spiral in the vagina (a spiral per animal);
- Day 7: intramuscular injection of PGF2α Enzaprost® (5 ml per animal);
- Day 9: removal of the PRID® Delta spiral and intramuscular injection of PMSG (eCG 500 UI) (2 ml per animal);
- Day 11: heats appear at the 48th hour and then the AI at the 56th hour after the removal of the spiral.

The heifer cattle subject to this protocol were separated from the bulls after removal of the PRID® Delta spiral until at least 15 hours after the AI. These heifers were identified by ear loops after the introduction of the PRID® Delta spiral.

Heat Observations

The major criteria for estrus considered are the acceptance of the overlap and immobilization of the heifer when overlapped by another heifer in the group, the presence of mucus, permeability of the cervix (Ponsart and Humblot 2002; Pitala et *al.,* 2012).

Pregnancy diagnostic (PD)

It was carried out through the rectal palpation between the 60^{th} and 90^{th} day after the AI. The diagnosed pregnant cows were monitored until calving for confirmation based on the phenotype of the veal/runt.

Measured parameters

The rate of estrus and calving reflecting the efficiency of induction and heat synchronization products, fertility of cows were calculated.

The rate of estrus, TO (%) (Number of cows having revealed the heats / number of treated cows x 100). The calving or actual fertility rate, TV (%) (Number of calving products living at least 48 hours / number of inseminated cows x 100).

The AI operation unit cost

The AI operation related expenses

Apart from the costs related to the import of goods from Dakar to Lomé, all the expenses have been consolidated into the four phases of the AI operation (selection, induction and synchronization of heat, AI itself and pregnancy diagnostic). These expenses covered the purchase of consumable and non- consumable inputs, fees related to transport to the farms and communication fees for appointments made with breeders.

The cost of consumable and non-consumable inputs (amortized over 5 years) was determined based on the invoices issued by the suppliers in Dakar and Lomé.

The transport from Lomé (ESA-UL) to the different farms was made through a rented bush taxi the price of which varies from CFA F(Franc of the African Financial Community) 10 000 to 25 000/ trip / farm based on the distances and accessibility. Sometimes due to their proximity 2 to 3 farms were visited during the same trip. A total of five trips / farm were made throughout the operation: three (03) for the selection and synchronization of heat, one (01) for the AI itself and one (01) for the pregnancy diagnostic.

The communication cost has been determined based on a lump sum rate of CFA F 6 000 for each operation.

Dia (CFA F) = (CIc + AInc +FI +FD +FC) /150 doses

Where,
Dia = insemination operation expenses/cow;
CIc = Cost of consumable inputs;
AInc = Amortization of non-consumable inputs;
FI = Import charges;
FD = Transport fees;
FC = Communication fees

The AI operation expertise cost

It is based on the cost of expertise offered by Kamga-Waladjo et *al.* (2016). In fact, it costs CFA F 14 000/cow distributed as follows: CFA F 2 000 for the selection, CFA F 5 000 for the synchronization and induction of heat, CFA F 5 000 for the AI itself and CFA F 2 000 for the pregnancy diagnosis.

Cia (CFA F) = Dia + Ce

Where,
Cia = The AI operation unit cost;
Dia = Expenses of the AI operation/cow;
Ce = Cost of expertise/cow

Statistical analysis

The results were expressed in percentage, in average ± standard deviation and the differences were considered as significant at the probability level of 5%. Moreover, the processing impact on various variables (estrus and heifer fertility) was appreciated using ANOVA. The various computer software used are: EXCEL 2007 and SPSS 20.

RESULTS

Estrus induction and fertility of the cows by artificial insemination

Out of 139 cows having gone through the induction treatment, only 10 did not come into heat, that is, an overall synchronization rate of 92.81%. The breed and parity significantly influenced ($p \leq 0.05$) the response of the estrus. The monitoring of 138 heifers cattle inseminated until calving allowed recording 47.1% of calving (Table 1). The parity, breed and management of the herds significantly influenced ($p \leq 0.05$) the fertility of the inseminated cows. Indeed, the cows fertility is on the one hand, more efficient in the stations than on the farms and on the other hand, better in cows than in heifer cows. The semen used and the districts where these farms are experimented have proved to be insignificant ($p > 0.05$) to that fertility.

Table 1. Heat induction and fertility of dairy cows treated using the PRID® Delta protocol

Factors		Estrus	Calving (actual fertility)
Parity	Heifers	89.19% (33/37)	24.32% (9/3 7)
	Cows	94.12% (96/102) *	55.45% (56/101) *
Breeds	Zebus Goudali	94.79% (91/96) *	47.91% (46/96)
	Other zebu	88.23% (30/34)	44.12% (15/34)
	N'Dama	88.88% (8/9)	50% (4/8) *
Herds management	Station	93.75% (15/16)	53.33% (8/15) *
	Farms	92.68% (114/123)	46.3 4% (57/12 3)
Semen used	HO	-	49.33% (37/75)
	MO	-	44.44% (28/63)

Values followed by * are significant ($p \leq 0.05$)

The AI operation unit cost

The AI operation unit cost is rated at CFA F 47579.37 including CFA F 5 466.66 (11.49%) of the transport fees and CFA F 2 124 (4.46%) of the import charges (Table 2).

An analysis of this cost without import charges gives 46.43% and 40.99% of the respective proportion of the heat synchronization and the AI itself (Figure 1).

DISCUSSION

The average rate of the estrus synchronization (92.81%) is consistent with the results of Diadhiou (2001) (92.8%) using the PRID® in Goudali and N'Dama cows in Senegal, Pitala et *al.* (2012) (94.87%) and Mbaye (1990) (92.8%) using Crestar® implant associated with PMSG and Ndiaye (1992) (93.8%) using Crestar® only in Senegal. However, it is less than 100%, corresponding to the results of Abonou (2007) using the PRIDND in Senegal with the zebu Azawak in Senegal, Issoufou (2012) with the PRIDND Delta in local cows in Senegal, Ouedraogo and *al.* (1996) in the zebu at the experimental station of CIRDES (Centre International de Recherche-Développement sur l'Elevage en zone Subhumide), in Banankélédaga in southwestern of Burkina Faso and Pitala et *al.* (2005) (96.9%) using Crestar® associated with prostaglandin and PMSG in Burkina Faso in the zebu Goudali. This rate is higher than that obtained by Marichatou et *al.* (2010) (43%) using the CM PRID spiral associated with the prostaglandin and 400 IU PMSG in the Azawack cattle in Niger, Tcheufo (2007) (78.4%) using the PRIDND in Gobra heifers in Senegal, Messine et *al.* (1993) (42.5%) using the subcutaneous implant alone at the Institut de recherche zootechnique of Wakwa in Cameroon.

The calving average rate (actual fertility) in local cows after estrus induction using the PRID® Delta protocol is within the limits (40-50%) reported by Mbaye et *al.* (1989); by Mbaye and Ndiaye (1993) in the Gobra zebu in Senegal; by Pitala et *al.* (2005, 2012) in the heifers zebu Goudali in Burkina, Goudali and Azawak in Niger and by Tada et *al.* (2010) in the zebu in Zimbabwe. However, these results are higher than those obtained by Diadhiou (2001) (27.7%) using Crestar® in the zebu Gobra in Senegal. It is worth noting that the same author obtained a fertility rate of 42.7% using PRID® in the same zebu breed (Gobra). The herds' management significantly influenced ($p \leq 0.05$) this fertility as reported by Data et *al.* (2010) in Zimbabwe. This fertility is also very dependent on the physiological state of the heifers (Zongo et *al.,* 2012) and the parity as reported by Freret et *al.* (2011). According to him the parity affects the fertility in the Prim' Holstein cows, the pregnancy rate is higher in the primiparous. All these factors affecting the pregnancy rate have been largely shown by Bouyer (2006) in various AI projects in Sudan-Sahelian Africa.

The unit cost of the AI operation by heat induction of this study is significantly higher than CFA F 32 000 and CFA F 35 867 corresponding respectively to the values reported in Mali and Senegal as part of the governmental projects on genetic improvement of diary

Table 2. Artificial insemination operation unit cost

N°	Designation	Total cost (CFA F)	Cost / cow (CFA F)	Comments
1	**Selection**			
	Ear loops	84 200	561.33	
	Amortization of the loop clamp	3 600	24. 00	
	Total 1	***87 800***	**585.33**	
2	**Heat synchronization and induction**			
	Heat synchronization hormones: PRID delta, PGF2α, PMSG	1 808 715	12 058.10	
	Synchronization consumables: PRID gel, Betadine, alcohol, search gloves, syringes, needles, soap, etc.	86 400	576.00	
	Amortization of PRID Applicator	10 286.4	68.58	
	Transport fees	492 000	3 280.00	
	Communication fees	18 000	120.00	
	Total 2	***2 415 401.4***	***16 102.68***	
3	**Artificial insemination itself**			
	Montbéliardes and Holstein semen: flakes in a 10 Liters nitrogen gas cylinder	1 316 328	8 775.52	CFA F 6000 / flake
	AI consumables: ducts, sanitary shirts, search gloves	51 525	343.50	
	Loading of liquid nitrogen (40 liters) + loading charges	420 000	2 800.00	8 loading (40 liters at CFA F 10 200 per liter) CFA F 1500/ loading
	Amortization of AI Equipment: AI Gun, Tweezers, 14CM Scissors, AI Box, flakes defroster	86 850.6	579.00	
	Transport fees	164.000	1 093.33	
	Communication fees	6.000	40.00	
	Total 3	***2 044 703.6***	***13 631.36***	
4	**Pregnancy diagnostic**			
	Search gloves	400	2.67	
	Transport fees	164,000	1093.33	
	Communication fees	6000	40	
	Total 4	***170 400***	***1136.00***	
5	**Expenses related to the import of products from Dakar to Lomé** (FOB costs, transportation costs + insurance + Import)	318600	2124	
Total expenses		**5036905**	**33579.37**	
Cost of expertise		**1800000**	**1 4000**	
AI unit cost		**71 36905**	**4 7579.37**	

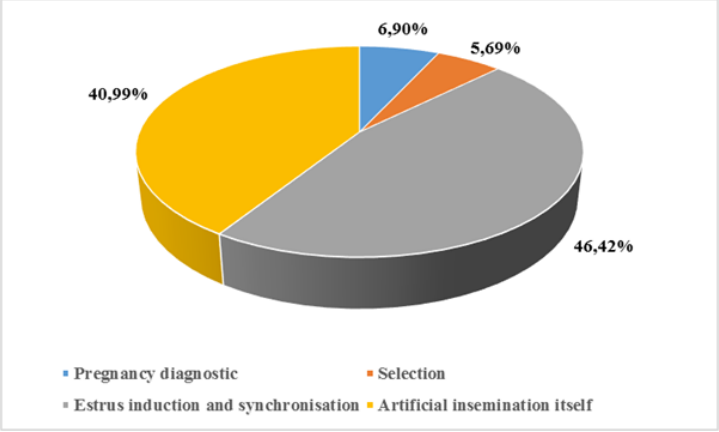

Figure 1. Distribution of the unit cost of the AI operation at the various phases

production (Bellinguez, 2001 Bouyer, 2006; Kamga - Waladjo et *al.*, 2016). This difference may be explained first by the fact that the amortization of the non-consumable materials and the import charges have not been taken into account in the calculation of the previous studies. In addition, in Senegal, the transport fees (4%) account for the third of this study and correspond only to the fuel costs because a 4x4 vehicle was made available to the research team. Finally, the cost of expertise (CFA F 7 445) in Mali accounts for almost half of that applied in Senegal and in this study. However, these unit costs of the AI operation by heat induction are much higher than CFA F 22.713 corresponding to the unit cost per natural heat in the Kolda region of Senegal (Kamga-Waladjo et *al.,* 2016). This difference is due to the cost of hormones used for synchronization. It is also profitable to promote the AI by natural heat provided that the breeders are trained and made available to a heat detection, which remains nowadays a limiting factor as it is very difficult and time consuming. In addition, the heat synchronization is very expensive compared to the other phases of the AI operation because it accounts alone for 46.42% of the unit cost of the AI operation. This proportion is slightly lower than the results of Kamga - Waladjo et *al.* (2016) (50%). This difference is the result of the above mentioned consequences.

CONCLUSION

The artificial insemination by heat induction using PRID® Delta protocol in southern Togo led to a success rate of 47.1% of calving and a unit cost of the AI operation by heat induction of CFA F 47.579.37. This high cost of the AI operation requires government subsidies in order to encourage breeders for its quick adoption. Moreover, it is necessary to train the breeder's on heat detection, the livestock agents on the practice of this biotechnology for better extension.

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